

# EXPLORING AN INNOVATIVE APPROACH TO STUDY BROWSING BEHAVIOR OF DAIRY COWS AND THE PERFORMANCE OF SELF-MECATIVE BEHAVIOR IN RELATION BROWSING

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## Abstract

To assess an innovative method, and to get a better understanding of browsing behavior of dairy cows and the performance of self-medicating behavior a 13-day preliminary trial was conducted. On a silvopastoral site of a Dutch organic dairy farm, data were collected with 4 wildlife digital cameras to register browsing behavior combined with cow-specific data including cows' health state and productivity. Dairy cows, in all four lactation stages, and calves made use of willow trees for browsing. Browsing frequency by individual cows however, was low. Browsing behavior could not be related to self-medication nor could potential benefits of fodder trees on animal health be clearly demonstrated. Current method may prove a valuable, accessible and cost-effective approach, and may be used as a stepping stone to future studies. However, we recommend that future studies would include: longer observation period with repeated measurements over time, higher coverage of the browsing area with more cameras, larger sample size and use of diverse groups, and day-to-day collection of a larger variety of physiological and medical data of individual cows.

**Keywords:** silvopastoral systems, self-medication, feeding behavior, animal health, animal welfare

## Introduction

Agroforestry systems are increasingly acknowledged for their environmental, social and economic benefits (Mosquera-Losada et al. 2012). Besides these benefits, livestock may also benefit from the integration of trees (Mosquera-Losada et al. 2012), as silvopastoral systems can contribute to improved animal health and welfare (Eekeren et al. 2014). Moreover, a recent study reported that also for the Dutch farmers these aspects are of importance as animal health and welfare were among the four key drivers that motivated them to implement agroforestry practices (Garcia de Jalón et al. 2017).

Previous studies showed the potential of certain tree species to serve as a supplementary source of macro- and micro elements (like protein, Ca, Zn, Se) for ruminants (Luske and Eekeren 2015). Moreover, certain tree species such as willow (*Salix spp.*), are known to contain active compounds with analgesic, anti-inflammatory, and anti-parasitic properties (Engel 2002). Therefore, there is reason to believe that there are more perspectives to understanding feeding behavior, and that feeding behavior may also be closely linked to health maintenance. Health maintenance can be both preventive and curative and therefore implies that animals are likely to exhibit self-medicating behavior (Engel 2002). However, little is known about the abilities of animals to self-medicate, especially the ability of domesticated animals such as dairy cows.

To further build upon the concept of agroforestry as a multifunctional approach, aspects of animal health and welfare cannot be left out of the equation. Consequently, the overall purpose of this study was to explore the potential benefits of the (re)integration of fodder trees on the health and welfare of dairy cows. A main objective therein was to develop a research

methodology that allowed for the identification of self-medicating behavior through browsing which could be applied in practical settings. To test this innovative method, and to get a better understanding of browsing behavior as well as the performance of self-medicating behavior in relation to browsing, we conducted a preliminary case study on an organic dairy farm.

## Materials and methods

### Study area

Current study took place at organic dairy farm de Kerckhoeve in Helvoirt (51°38'15.65"N; 5°12'27.58"W), with 130 Holstein Friesian cattle. The silvopastoral site comprised an area of 9000 m<sup>2</sup> and included ten tree rows with fodder trees, adjacent to the normal pastures. The silvopastoral site included alternating rows of basket willow (*Salix viminalis* incl. two different cultivars) and common alder (*Alnus glutinosa*). Trees were planted in 2011, and from spring 2015 cows were given access to the site.

On the farm, calves are reared in a suckling system and are allowed to graze with the dairy herd. Furthermore, current farm makes use of an automated milking system which allows for the monitoring of cows on both herd and individual level.

### Study design and data collection

To study browsing behavior of dairy cows, four wildlife digital cameras (Dörr Snapshot Mini 5.0 MP, Model -UV555) were installed at the silvopastoral site. Cameras were predominantly placed adjacent to the willow tree rows (3x; 1x alder row). A previous study showed that dairy cows preferred willow over alder trees based on a higher number of browsing marks found on willow trees (Luske et al. 2017). For a period of 13 days, between August 7th-25th 2017, the cameras registered browsing behavior of dairy cows. Wildlife digital cameras took photos based on motion detection (2 shots per motion, 60 sec. interval), and registered date, time and temperature for each photo. Browsing cows were identified by their neck- or ear tags.

To get insight into the cows' health state and level of productivity, data from all individual cows (browsing and non-browsing) were retrieved from the automated milking system and CowVision program in cooperation with the farmer. The CowVision program was used to obtain information on the cow's disease history (like claw and leg injuries), parity (no. of lactations), and stage of lactation (no. of days in lactation), and to collect relevant information from three milk production registration sampling moments (MPR 28-6 / 12-8 / 26-9 '17). MPRs provided information on somatic cell count (SSC), and fat- and protein content in milk (%) for each individual cow. SSC served as an indicator for mastitis; and (deviations in) fat- and protein content (%) served as an indicator for metabolic disorders (like ketosis and milk fever).

Cows were grouped as browsing cows (BC) (i.e. cows identified browsing on camera) or non-browsing cows (NBC). BC and NBC were further divided into subgroups according to their stage of lactation: (1) ≤ 60 days; (2) 61-180 days; (3) 181-304 days; (4) >305 days in lactation respectively.

### Data analysis

Data obtained from the camera captures was used to calculate the total number of browsing incidences (per tree row), timing of browsing (morning or afternoon), duration of browsing incidences (min.), and browsing frequency per individual cow.

Data was further analyzed using IBM SPSS Statistics 24. Statistical procedures were performed to compare BC and NBC, subgroups (stage of lactation) of BC and NBC, and to compare subgroups within the group of BC. A parametric Independent T-test was used to test for differences in average no. of lactations, SSC (for all three MPR sampling moments), and fat-and protein contents in milk (%) (for all three MPR sampling moments) between (sub)groups. A non-parametric Kruskal Wallis test and multiple comparisons were performed to test for differences in the distribution of browsing frequency within the different lactation groups of BC. A linear

regression was performed to check for possible correlations between parity and average SSC (i.e. #SSC for each MPR sampling moment) of BC and NBC respectively.

## Results

### Describing browsing behavior

At time of observation, 117 cows had access to the silvopastoral site. Cameras revealed browsing behavior of 36 different identifiable animals (incl. 2 calves) (Figure 1) opposed to 81 individual cows that were not registered browsing. Cows and calves browsed from willow trees but not from the alder trees. Fifty-nine browsing incidences were registered over three different willow tree rows. Most browsing incidences ( $n=29$ ) occurred at one willow tree row which was a wider growing branching out willow cultivar ("Klara" cultivar). In 8 cases, cows seemingly browsed from the trees but could not be confirmed as the identification of these animals was not possible.



Figure 1: Wildlife cameras were used to capture images of browsing cows (and calves). Neck/ear tags enabled the identification of the individual animals within the herd.

Most browsing incidences (48%) took place in the afternoon, between 3:00 and 5:59 pm. About 30% of the total number of browsing incidences took place between noon and 2:59 pm. The remaining 20% of browsing incidences occurred (early) in the morning (between 6:00-11:59 am). Often browsing incidences lasted no longer than one minute (60%), whereas about one-third of the total number of browsing incidences lasted between one and five minutes ( $n=18$ ). Less than 10% of the browsing incidences lasted longer than five minutes or longer than ten minutes.

Two individual calves were spotted browsing three to four times, respectively. Browsing behavior of calves was always observed in combination with browsing behavior of the mother cow (Figure 1) and/or with peers. Laying behavior often preceded or followed after browsing.

### Browsing behavior related to individual cow data

Irrespective of lactation stage, on average 63% of the dairy cows browsed once during the entire observation period, followed by 22% of the cows that browsed twice (Figure 2). Forty percent of the cows that were seen browsing twice were part of the second lactation group (61-180 days), whilst 25% were part of the first lactation group ( $\leq 60$  days) (Figure 2). On average, less than 10% of cows in lactation group 1 ( $\leq 60$  days), and group 3 (181-304 days) browsed more than twice, while 40% of cows in group 4 ( $\geq 305$  days) browsed more than twice. The distribution of browsing frequency did not significantly ( $p>0.05$ ) differ between the different lactation groups of BC.

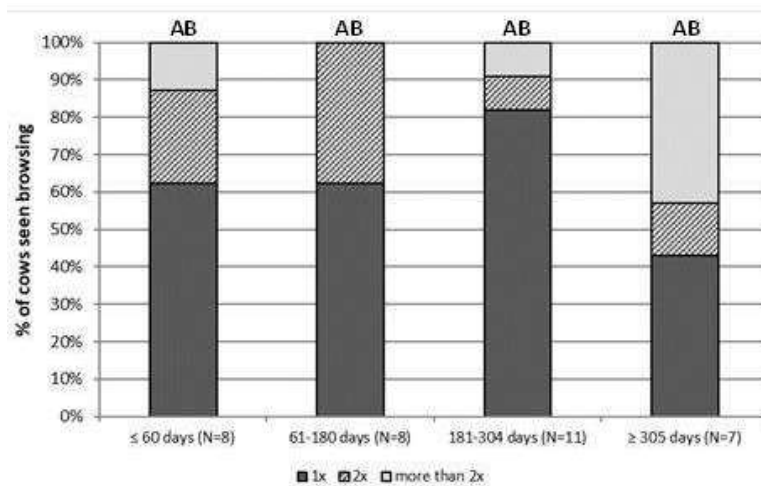


Figure 2: Frequency of dairy cows (N=34) spotted browsing according to their lactation stage. AB indicate that no significant differences in the distribution of browsing frequency between groups were found ( $p > 0.05$ ).

The average no. of lactations (parity) of BC was significantly ( $p < 0.05$ ) lower ( $2.8 \pm 1.3$ ) compared NBC ( $3.5 \pm 1.9$ ).

Across the three MPR sampling moments no significant differences in average SSC between the four different lactation groups of BC and NBC were found. No significant relation was found between parity and average SSC of BC, whilst a significant ( $p < 0.05$ ) though weak ( $p = 0.322$ ) relation was found between parity and average SSC of NBC.

## Discussion and conclusions

With this explorative case study we tested an innovative method that included the use of wildlife cameras to register browsing behavior of dairy cows, and subsequent combination of this information with relevant cow specific data regarding health and productivity of individual cows. Although the number of cameras used in this preliminary trial was limited (4), and the observation period was short (13 days) we were able to collect some initial data to study browsing behavior of dairy cows. We found that dairy cows, across all four lactation stages, mostly younger cows, and even calves were captured browsing from willow trees on a frequent basis, but that browsing by individual cows was rather an occasional activity. Such findings suggest that the (in) ability or willingness to browse may be a function of experience, or possibly the lack thereof. Several studies showed that past experiences, social learning processes (like from mother to young), and diversity of environmental circumstances in which animals were reared, play a fundamental role in the development and adoption of dietary habits and foraging skills of domesticated ruminants (Provenza and Balph 1987; Villalba and Provenza 2007; Vandermeulen et al. 2016).

Field pictures were of good quality which enabled the identification of individual animals. We were also able to collect the required information from individual cows which allowed the comparison of browsing and non-browsing cows or other sub groups within the herd. More often dairy farms in the Netherlands are equipped with modern technology, which enables monitoring and registration of animal health parameters on a daily basis. As shown in the current study, the application of modern technology can be considered a valuable tool to study and better understand the complexities of animal behavior, including the act of self-medication. During this experiment however, we had difficulties retrieving daily data from the computer system of the milk robot. In future projects it is therefore advised to consult an expert at an early stage to make sure relevant data is accessible to researchers. These daily measurements will be key to link browsing incidences with relevant physiological data of identified cows.

This study did not provide sufficient evidence to prove the performance of self-medicating behavior among dairy cows. However, it is generally difficult to make a distinction between self-

medication and nutrition, whilst both are means to the same end: stay well. Furthermore, according to Engel (2002) it is clear that daily feeding behavior, and therewith choosing the right diet at the right time under the right circumstances, is inextricably linked to health maintenance. From this perspective, and the notion that browsing behavior is a function of social learning processes and experiences, it may be more appropriate to speak of self-regulation or homeostatic behavior (Engel 2002). Furthermore, the possibility to exhibit browsing behavior as well as having dietary choices contribute to an improved animal welfare by allowing the expression of natural behaviors, a better fine-tuning of the cow's individual needs and preferences, and overall reduction of stress (Villalba and Provenza 2007; Manteca et al. 2008).

Altogether, this trial did demonstrate the potential of our method to study self-medication in future research. Additionally, the approach can be used to study other beneficial effects of trees for dairy cows, like the provision of shade in pastures and the physiological effects on cows. Overall, current method may prove a valuable, accessible and cost-effective approach, and may be used as a stepping stone to future studies, provided these would be more properly designed to study self-medicating behavior. We suggest that an improved study design would include a longer observation period with repeated measurements over time, a higher coverage of the browsing area with more cameras, a larger sample size and use of diverse groups (considering both lactating and dry cows; sick and healthy animals; with and without access to medicinal plants) and day-to-day collection of a larger variety of physiological and medical data of individual cows.

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